



NOx Reduction through Cetane Enhancement in Heavy Duty Diesel Engines

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EPA-OTAQ Aid to the States

- **EPA Office of Transportation and Air Quality (OTAQ) final technical report “The Effect of Cetane Number Increase Due to Additives on NOx Emissions from Heavy-Duty Highway Engines”**
 - ◆ Includes formula for calculating “baseline” NOx emissions
 - ◆ Includes formula for calculating %NOx reductions
 - ◆ Includes yearly discounts for 4 cycle EGR introductions
 - ◆ In general, 2% NOx reduction for a 5 number increase in cetane (acquired through cetane enhancer)
 - ◆ Technology is “officially” approved through EPA’s Environmental Technology Verification (ETV) process
 - ◆ States can use as a “tool” to meet NOx emissions reduction requirements

Quantifying the % NOx Reductions

- **States need to develop a protocol to convert %NOx reduction to NOx tons reduced per day (or per year)**
 - ◆ Quantification protocol = %NOx reduction X “baseline” NOx emissions
 - ◆ “Baseline” NOx emissions = What NOx emissions would be in the absence of new technology
 - ◆ States submit quantification protocol to EPA Region for approval

- **Infineum has developed a pro-forma quantification protocol to convert “%NOx reductions” to “tons of NOx reduced per million gallons of cetane enhanced diesel fuel consumed”**
 - ◆ Assumptions: “typical” engine BHP, fuel economy, speeds, etc.
 - ◆ Discounts: 4 cycle EGR introductions, diesel fuel burned outside the States or local area
 - ◆ Submitted to OTAQ asking for comment/guidance

Cetane NOx Reduction Protocol- Assumptions

- %NOx reductions based on EPA formulae
- 4 cycle EGR discount multipliers taken per EPA paper:
 - 2004, factor = 0.84
 - 2005, factor = 0.77
 - 2006, factor = 0.70
 - 2007, factor = 0.65
- Per TCEQ, yearly diesel fuel consumption in HGA is 1.262 billion gallons (~70% to on-highway; ~30% to off-highway)
 - Assume major diesel fuel supplier = 157.75 million gallons per year (12.5% market share)
 - Assume 50% of on-highway diesel is used "outside" HGA

Infineum Proforma Protocol Example

			Cetane Improved		Baseline		
			<u>NOx</u>		<u>NOx</u>		
Additized Cetane Number Increase			5		0		
Natural Cetane Number			43		43		
				note: F12=D10			
Total Cetane			48		43		
% Change in NOx <small>note 1</small>			-2.33		0		
NOx emissions (g/bhp-hr) <small>note 2</small>			4.56		4.665653919		
		Baseline NOx	% Diesel Fuel	% Diesel Fuel	4 Cycle, EGR	%NOx	NOx Reduction
		(tons/MM gal.)	Distribution	used in State	Discount	Reduction	(tons/MM gal.)
On Highway Diesel		328	70.8	50	0.84	2.33	2.27
Off Highway Diesel		328	29.2	100	1	2.33	2.23
							TOTAL
							4.50
<u>Absolute NOx Reductions</u>		Vol. Cet.Add.	NOx Reduction		Total NOx		
		Diesel Fuel	per MM gallons		Reductions		
		(MM gallons)	(tons/MM gal.)		(NOx tons)		
		157.75	4.50		711		

Cetane NOx Reduction Scenarios

Δ Cetane #	% NOx reduction	NOx tons/MM gal
43→48	2.33	4.50
43→52	3.57	6.90
48→52	1.49	2.70
52→55	0.91	1.62
52→58	1.51	2.70



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